and trouble are not allowed to appear in the ward, and no one is aware that the head nurse is sick or upset in any way. Thus, by keeping good control of herself she conquers all obstacles and is looked up to and loved and honored by those connected with her. When she enters the homes of others as private nurse, seeking to make a reputation for her own future welfare, she will be a comfort to those in grief or trouble by her calm personality and the quiet self-control which leads the weary and heart-sick members of the family to rely on her and to put their burden on her strong shoulders, feeling that she is to be trusted until they can take it up again. She may never realize what she has been to those in affliction, but they will always remember her. Her position in the hospital has neither made her arbitrary nor domineering, but has brought out and developed those qualities that are purely womanly, that she may have been unconscious of possessing. It will never be said of her that she is lacking in sympathy or tactfulness. Her very presence will be a blessing in the household of the suffering.

I do not doubt it will take years to acquire the self-control and self-poise so necessary to develop the self-disciplined nurse.

THE ESSENTIALS OF BACTERIOLOGY *

By JAMES W. HUNTER, JR., M.A., M.D.
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A PART of your education as nurses has been neglected, unless you possess some little knowledge of the bacteria,—on one hand, our deadliest enemies; on the other, our warmest friends. To you the medical profession intrusts the lives of its patients, and it is well that you should know the nature of the cause of the ills which you seek to cure.

It has been said that the bacteria are, on the one hand, our deadliest enemies, and, on the other, our most valued friends. Let me emphasize this; let me illustrate more clearly. The causes of almost all diseases have been proved to be bacteria,—for example, diphtheria, scarlatina, pneumonia, tuberculosis, erysipelas, all kinds of pus, and a host of others. These we must fight as long as we live, and the length of our lives, in the majority of instances, depends upon which has the stronger sustaining power, the bacteria or ourselves. It is another phase of the Darwinian axiom of the survival of the fittest. And yet were it not for the bacteria there could be no vegetation, no animal life, no life of any sort,—only a

* Read to the nurses of the Norfolk Protestant Hospital.

dreary earth, a mass of death. For you must know that the nitrifying action of the bacteria of the soil allows the growing plants to assimilate certain elements which otherwise they could never obtain. Again, the beneficent action of certain water bacteria changes nitrites into nitrates, making it far more wholesome. Thus it is that in the rotting of animal and vegetable matter, the bacteria remove that which is offensive, and render this same material productive of the highest good.

You should remove another fallacy from your minds. Morphologically and physiologically considered, the bacteria are plants, not animals. All animal and vegetable material is composed of cells, but with this difference: an animal cell has no encircling wall; a vegetable cell has. Judged by this standard, the bacteria are plants. The plant receives carbon-dioxide, nitrogen, oxygen, hydrogen, iron, soda, potash, etc., and builds up more complex bodies, chlorophyll (the green coloring material of the leaves), starches, sugars, oils, and albumins. Animals, on the contrary, receive the completed products from the vegetable world, assimilate to their own bodies that which they wish, and return carbon-dioxide, water, and urea. Thus plants take the elementary substances and build up more complicated ones; animals destroy these products, and give off simpler ones. Judged also by this standard, the bacteria are plants.

Having now determined that the bacteria are plants, let us try to find their place in the vegetable world.

There are four great divisions of this world: *first,* the seed plants, or Spermaphytes; *second,* the ferns, or Pteridophytes; *third,* the mosses and lichens, or Bryophytes; and, *fourth,* a group called, for lack of a better name, the Thallophytes. In the first three classes there exists a differentiation of the plant into root, stem, and leaves; in the Thallophytes, no such arrangement exists.

The manner of reproduction also differs. In the seed-plants there exists in the blossom one, and sometimes two, long stamens, the pistil, this is the female element, and in it grow several ova. The other stamens produce a pollen, these are the male elements. Now the pollen, scattered by the winds and by certain insects, notably by bees, comes in contact with the ova, penetrates them, and thus gives rise to a fertilized oosperm, or seed, which in turn develops a new plant. The seed is surrounded by a dense fibrous envelope, where food, as well as life, is enclosed. Often if we will examine a seed, a miniature copy of the future plant will be found. Owing to our examination, however, that plant will fail to realize.

But with the fern there is no proper seed. True, certain spores are developed on the under side of the leaves, which fall into the ground, and in due time another fern appears. Yet the new fern is not the off-

spring of the old, but, so to speak, its grandchild. The spore falling into the ground has developed into a new organism, the gametangium, which in turn has given rise to both germ- and sperm-cells; the sperm-cells have fertilized the ova, and from the oosperm so formed a new fern arises . Thus there is an alternation of generations.

In the mosses and lichens, however, there may be a suppression of either the sporophyte or the gametophyte stage. But in the majority of the mosses there are developed by the plant both male and female elements; the male element fertilizes the ovum, and the oosperm is cast away. This finds root and a new organism is formed. The daughter marries and goes to housekeeping with her husband. With the lichens, on the contrary, the fertilized oosperm remains with the parent plant. The son-in-law and his wife thus live upon the father-in-law, who in turn dies, and the younger folk take complete possession, until they in turn are superseded.

With the Thallophytes all is changed. Reproduction, for the most part, takes place either by fission or by spore formation, though sometimes a budding occurs. By fission is meant a simple division of a cell, whereby two cells are formed; thus one plant becomes the ancestor of many. By spore formation we describe a process in which the fibrous material formed in the cell, the chromatin, is concentrated into one mass. These may remain in the cell or be expelled. They lie dormant for a while; in due season, however, other plants spring into being. The spores are very hardy; they can stand much rougher treatment than the plant itself.

The Thallophytes are subdivided into fission algæ and fission fungi. These last are the bacteria. They are, for the most part, unicellular organisms; some have a pair of legs or flagellæ, by means of which they swim; some are motile, some not so; they form colonies, some in chains, some in clusters; some are double, some grow only in one division of space, some in two, some in all three; and some prefer one medium for culture, some another. Thus we have a means of differentiating them. Moreover, they take different stains.

But do not imagine that all algæ multiply by fission. Many of them develop both male and female elements as well, only one ovum, however, forming in its respective cavity, and from four to eight sperm-cells in their place. The male elements are provided with a pair of cilia for purposes of movement; they swim towards the ova, penetrate them, and in due season the fertilized oosperm is expelled from the parent plant.

Thus we have shown the true relation of the bacteria to the vegetable world. They are unicellular organisms, and multiply either by fission or by spore formation.

That the bacteria cause disease is now but little questioned. Yet the most absolute ignorance of this fact prevails among the laity, and, I regret to say, among some of the profession. Just as for years after the death of Copernicus many astronomers refused to accept the doctrine that the earth revolved around the sun, so many of the older physicians refuse to believe that diseases are caused by bacteria. What is more, they have no idea of practical asepsis; and, I regret to add, they do not care.

Happily for us, Professor Koch has for all time settled the question. Had he done nothing more than to formulate his famous dicta, his name would have been written high upon the pediment of the Temple of Fame. To be the cause of any disease, the suspected bacterium must be found in the tissues of an animal sick or dead from that disease. Nay, more, it must be isolated and cultivated through many generations outside of the body. An animal must be inoculated with some of the new culture, the disease in question must appear, and the bacterium itself found in the tissues of that animal. When these conditions have been complied with (and only then), we say that the bacterium is the cause of the disease. Could any proof be more positive?

It is useless to trouble you with an elaborate classification of the bacteria, but you should understand the fundamental forms which the bacteria assume. A round or oval bacterium is called a coccus. If it exist in bunches, it becomes a staphylococcus; if in chains, a streptococcus; if in pairs, a diplococcus, and so on. A rod-shaped bacterium, on the other hand, is a bacillus. Thus we have the B. Diphtheriæ, Tubercle Bacillus, etc. Originally the short rods were known as bacteria, the longer as bacilli. But, fortunately, this differentiation is no longer recognized. The term bacterium has become generic. Again, if the bacterium assumes a spiral form, it is a spirillum; and if short, a comma, from its resemblance to that mark of punctuation. And of these perhaps the deadliest is the famous comma of Koch, the spirillum of Asiatic cholera.

The bacteria may also be classified according to whether they do or do not require oxygen for their existence. Those requiring oxygen are called aërobic, those to whom oxygen acts as a poison anaërobic, while those ordinarily living in the air, but capable of existing without oxygen, are known as facultative anaërobic. And right here let me call your attention to a very important fact. You have heard it said (and you thoroughly believe it) that no life can exist without oxygen. With one exception, this is strictly true, and that exception is the anaërobic bacteria. The bacilli of tetanus and of malignant œdema, two of the deadliest of all the bacteria, are strictly anaërobic. Woe to the man so unfortunate as to become the prey of either!

A still broader classification of the bacteria would divide them into saprophytes and parasites,—a saprophyte being one that lives upon decaying organic matter, a parasite on living material. Thus the bacteria of the soil, as well as that in the intestine, the B. Coli Communis, are strictly saprophytic. On the other hand, those bacteria causing pus and all manner of diseases are parasitic, though most of them can be grown upon nutrient media. Thus they are persuaded to renounce a state of parasitism for one of saprophytism. The odor of a culture upon any medium will convince you of this fact.

Bacteria prefer different media, though happily most of them can be cultivated upon the potato or upon bouillon, either in a fluid state or with gelatine or agar-agar (a gelatinous sea-weed from Japan) added. Yet this is not true at all. Glycerine must be added to obtain a culture of the Tubercle Bacillus; that of diphtheria grows best on a specialized blood serum devised by Löffler, while the typhoid bacilli, though growing readily upon ordinary media, can be cultivated, to the exclusion of certain others, by the addition to the gelatine or agar of a large quantity of grape-sugar. Thus you will see that the manner of growth upon the different media, furnishes us with another means of identifying the bacteria. And it may also be added that the bacteria grow best at the temperature of the human body.

Of the way that the bacteria act many theories have been formulated. These we shall briefly discuss.

It was suggested that the bacteria acted mechanically by obstructing the various tubercles of the body of the patient. But this cannot be. Though the B. of Anthrax was found in large numbers in the capillary tubes of persons dying of that disease, it has been conclusively proved that no mechanical action caused the disease. Thus the mechanical obstruction theory falls to the ground.

Yet some other ingenious minds devised another theory. The bacteria were supposed to deprive the system of its nourishment. This certainly was ingenious; observation of certain diseases seemed to confirm it. Yet it was noticed that in the case of persons dying from anthrax or tetanus there were no signs of emaciation; nor could the changes in temperature be thus accounted for. So this theory, like the other, must be abandoned.

Again, it was thought that the air was withdrawn from the system by the bacteria, who appropriated the oxygen to themselves. But how about the strictly anaërobic bacteria? Moreover, sick persons do not always die from suffocation. Therefore this theory, like those preceding, is unsound.

Still another theory is left. This is known as the zymotic, or fer-

mentative, theory of bacterial action. As the common yeast-plant, the Saccharomyces Cerevisiæ of the botanist, splits sugar into alcohol and carbon-dioxide in the rising of bread, so a split fermentation takes place among the fluids of the body. Deadly toxines and ptomaines are formed, and it is these acting upon certain centres of the brain that cause the symptoms so common to the ordinary diseases. You know them well,—fever, loss of consciousness, increased respiration, etc. And, further, as no animal can live in its own excreta, so an antitoxine is formed in many diseases, and this tends to cure the patient. Thus the supporting treatment for diseases is coming largely into favor. The life or death of the patient depends upon the ability of the system to resist the bacterial invasion. All points of observation are satisfied by this theory, and it should be added that it is now universally believed.

But are there no methods of getting rid of the bacteria? Yes, fortunately, there are. You may use chemicals, especially bichloride of mercury, carbolic acid, permanganate of potash, formaldehyde, and a host of others. But let me warn you against a too fond belief in the chemical method of sterilization. The outside of the object may be absolutely sterile, but the inside as foul as ever. You may soak catgut affected with anthrax almost indefinitely in bichloride of mercury, but woe to the patient upon whom it is used! As sure as the sun is in the heavens, that patient will contract the disease.

Thus we are face to face with another question. The only perfect method of sterilization is by the employment of some form of heat. Dry heat is good, but the articles sought to be sterilized are often ruined. Moreover, a longer time and a higher temperature are required. Moist heat is best, and this can be obtained either by the use of steam, as in the Koch or Arnold sterilizer, or by boiling. The choice of either method must be regulated according to the articles to be sterilized. Dressings are best sterilized by steam, instruments by boiling.

Again I warn you, do not put too much confidence in either carbolic acid or bichloride; the only perfect method of sterilization is by the use of heat. But often, as in the case of the hands, this is out of the question; hence chemicals must be used. And do not think that one sterilization is going to be enough. Some spores will resist the temperature of steam. In such cases either superheated steam must be used, or the articles sterilized on three successive days, in order that the newly hatched crops of bacteria may be destroyed.

You cannot be too careful in your asepsis. Dirt is the greatest enemy of the human race. You must not introduce any microörganism into the human system; you should strive to conserve the patient's strength. Think, I beseech you, upon the fatal result of the introduction

of anthrax, tetanus, malignant œdema, tuberculosis, erysipelas, or any of the pus germs, especially the streptococcus, into the tissues of a patient! Think of it, I beg you, and be ever on the alert. Such a crime is little short of murder. Let me repeat it: the bacteria introduced into our tissues are our deadliest enemies; outside of the body they may be our friends. Strive by all means in your possession to get rid of all sepsis, for your lives and mine must be largely spent in fighting the bacteria.

THE WORK OF THE INDIAN ARMY NURSING SERVICE *

By MISS WATT
Allahabad, India

In attempting to give a brief account of the Indian Army Nursing Service, its advantages and disadvantages, in a way which may possibly be helpful to some intending candidate, two difficulties present themselves: first, that it is almost impossible to give an accurate picture of Anglo-Indian life to those who are strangers to it; in the second place, it must never be forgotten that fifteen years have to be spent in any part of India, and no one can foretell the effects of climate on the health.

Fifteen years' hard labor in a trying climate ought only to be attempted by the vigorous and strong. A weakly, delicate woman is not only a burden to herself, but a source of never-ending anxiety to her superiors, while her work must necessarily be less well done, however excellent her intentions.

All the rules and conditions of the service are clearly laid down in a small blue-book issued half yearly. This in itself is no small advantage, as before engagement all the rules can be studied and each candidate can be sure of the nature of her agreement.

Application for admission is made in the first instance to the Under Secretary of State for India, India Office, S. W., and a form is received which must be accurately filled up and returned with the numerous necessary certificates attached.

If the candidate be accepted, she receives fifteen pounds outfit allowance (which is quite insufficient), and she will probably be ordered to embark on a transport about a month after appointment.

Pay begins from date of embarkation, with the addition of exchange compensation allowance, and the deduction of income tax (which always

* Sent to the International Congress at Buffalo, September, 1902.